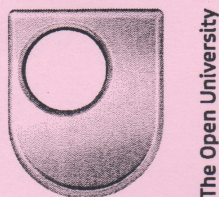


S 855650



Faculty of Mathematics and Computing

## MS221 – Exploring mathematics

### Mailing 2 Stop Press 2006

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#### 1 Essential course information

##### (i) Errata

*You may find, if you have received the latest edition of any of these texts, that some of the corrections below have already been made. Apologies for the inconvenience caused by these errata. Note that a negative line reference indicates counting from the bottom of the page.*

*MS221 Study calendar, MST121/MS221 Study Calendar*

Study week 9 TMA02 cut-off date 8 June

*MS221 Chapter C1*

Page 38 Frame 2, Step 6

The maximum point should be marked as  $(1, \frac{1}{2})$

*MS221 Chapter D3*

Page 43 line 3

... a **frieze** is a plane set whose symmetry group **contains** non-trivial translations ...



Page 43 line -9

A **wallpaper** is, ..., a plane set whose symmetry group **contains** non-trivial ...

MS221 Exercise Booklet D

Page 18 Solution 1.3(b)

$$q_{\pi/2} \circ q_{\pi/4} = r_{\pi - \pi/2} \pmod{2\pi} = r_{\pi/2}$$

MS221 Specimen Examination Paper

Page 1 Add to end of second paragraph

You should start your answer to each question on a new page.

Page 6 Question 1

General solution is  $u_n = A4^n + B(-1)^n$ ,  $n = 0, 1, 2, \dots$

...

The required closed form is  $u_n = \frac{1}{5}4^n + \frac{14}{5}(-1)^n$ ,  $n = 0, 1, 2, \dots$

## 2 General course information

### (i) Mathcad file 221C3-01 – applies only to Mathcad course files issued pre-2006

Please note that the graphs on page 4 of the worksheet will not appear as intended with certain types of function, for example,  $f(x) := \ln(1+x)$  or  $f(x) := (1+x)^{1/2}$ . A known means of correcting the file for functions of these types is as follows.

- Place the top of page 2 of the worksheet at the top of your (maximised) window.
- Scroll right, past two blank pages. On the third page to the right, you should be able to see the program called odd\_even\_test(f,x).
- Edit the first line of this program so that 'if  $f(x) = -f(-x)$ ' is replaced by 'if  $\text{Re}(f(x)) = \text{Re}(-f(-x))$ '. (To assist here and in (d) below, you might first move the text words 'ODD' and 'EVEN' to the right, to create more space.)
- Similarly, edit the second line of the program so that 'if  $f(x) = f(-x)$ ' is replaced by 'if  $\text{Re}(f(x)) = \text{Re}(f(-x))$ '.
- Save these changes to the file (having made no other changes). Then close the file and re-open it.

In addition, for functions such as  $(1+x)^{1/2}$  that involve fractional powers, it is necessary to add a decimal point to either of the integers within the fraction when entering the function.

### (ii) Audio and video material

#### Audio

The audio materials for MS221 were originally presented on audio cassette. For that reason, you may come across old references to tapes or cassettes, whereas the material is now presented in digital format. To help you navigate around the audio, we suggest that you note down the track number on your player whenever you are asked to stop or pause the audio material. You should also note the following adjustments to the text referring to the audio material.

| Reference     | Current text                                                                     | Replacement text                                                      |
|---------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| C1<br>page 5  | Section 3 requires the use of an audio cassette player, ...                      | Section 3 requires the use of an audio CD player, ...                 |
| C1<br>page 29 | To study Subsection 3.2 you will need an audio cassette player and Audio Tape 2. | To study Subsection 3.2 you will need an audio CD player and CDA5494. |
| C1<br>page 36 | Now listen to Audio Tape 2, Band 1, 'Graph sketching'.                           | Now listen to CDA5494 (Tracks 1 - 6), band 1, 'Graph sketching'.      |



|               |                                                                                                                           |                                                                                                                           |
|---------------|---------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| C2<br>page 4  | ... and in Section 3 you will need access to an audio cassette player.                                                    | ... and in Section 3 you will need access to an audio CD player.                                                          |
| C2<br>page 32 | <i>Now listen to Audio Tape 2, Band 2, 'Integration by substitution'.</i>                                                 | <i>Now listen to CDA5494 (Tracks 7 - 10), band 2, 'Integration by substitution'.</i>                                      |
| D4<br>page 4  | Section 1 is based on an audio tape ...<br>... with your study of Sections 2 and 3 before listening to the audio tape ... | Section 1 is based on an audio band ...<br>... with your study of Sections 2 and 3 before listening to the audio band ... |
| D4<br>page 8  | <i>Now listen to Audio Tape 2, Band 3, 'Aspects of proof'.</i>                                                            | <i>Now listen to CDA5494 (Tracks 11 - 17), band 3, 'Aspects of proof'.</i>                                                |

### **Course video**

The video materials for MS221 were originally presented on video cassette. For that reason, you may come across old references to tapes or cassettes, whereas the material is now presented in digital format. You should also note the following adjustments to the text referring to the video material.

| <b>Reference</b> | <b>Current text</b>                                                       | <b>Replacement text</b>                                                                        |
|------------------|---------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| C1<br>page 4     | There is an optional video band, Video Band C(i), associated ...          | There is an optional video band on DVD00115, band C(i) 'The birth of calculus', associated ... |
| C2<br>page 4     | Section 1 requires the use of a video player, ...                         | Section 1 requires the use of a DVD player, ...                                                |
| C2<br>page 6     | To study Subsection 1.4, you will need a video player and the Video Tape. | To study Subsection 1.4, you will need a DVD player and DVD00115.                              |
| C2<br>page 21    | <i>Now watch the Video Band C(iii), 'Integration'.</i>                    | <i>Now watch the band C(iii), 'Integration'.</i>                                               |
| D1<br>page 33    | <i>Now watch Video Band D(ii), 'Roots of polynomials'.</i>                | <i>Now watch DVD00115 band D(ii), 'Roots of polynomials'.</i>                                  |

### **(iii) Assessment Calculator**

You can check your current overall course result at any stage by using the Assessment Calculator in the Course Record section of your on-line StudentHome webpage. Any TMA and CMA scores on your record are pre-filled, and then you need to estimate your score for any remaining assignments. Obviously the more assignment scores that are pre-filled the more accurate the predicted overall course result will be.

### **(iv) Mathcad for future use**

As the Open University's terms and conditions of software use state, you may use the Mathcad program you have received only for educational purposes to do with an OU course for which you are registered. You should also note that if you are going on to study MST209, MSXR209 or M373, then Mathcad will continue to be supplied to you by the University for the duration of your studies. MST209 and MSXR209 use the same version of Mathcad as MS221, and the same OU terms and conditions of software use will apply. If, however, you wish to use Mathcad for educational purposes other than OU study, then you will need to purchase a student edition of Mathcad from Adept Scientific plc (the UK distributors of Mathcad). The cost of the student version is £65 excluding delivery and VAT. This price is subject to change without notification. You can order your student edition directly from Adept Scientific but you will need to provide proof that you were registered on an OU course using Mathcad for the year just finished or are currently registered on such a course. After that time you will only be eligible to purchase a Mathcad upgrade which although dearer, is still cheaper than the commercial price.



To order the student version of Mathcad or a Mathcad upgrade you must provide Adept Scientific with the following:

- A photocopy of any printed communication from the Open University which clearly states your name, code of your course which uses Mathcad, and your year of studying that course (e.g. your registration or results letter)
- Delivery address
- Invoice/home address if different from above
- Daytime telephone number or e-mail address for any order queries
- Payment - cheque or credit/debit card details (Visa/Mastercard/Amex/Switch/Delta/Solo)

There are several ways of ordering.

- To save on delivery charges, you can order on-line from the Adept Scientific webstore, [www.adeptstore.co.uk](http://www.adeptstore.co.uk). The product code you will need is MAT-SU-STUD. If you order using the webstore, you can either fax your printed proof of OU study to 01462 480213, or scan it and e-mail it to [education@adeptscience.co.uk](mailto:education@adeptscience.co.uk). Since delivery is free for on-line orders, the total price for the student edition is £76.38, including VAT.
- By post to Adept Scientific plc, Amor Way, Letchworth, Hertfordshire SG6 1ZA. The total price for the student edition is £88.13 including delivery and VAT.
- By phone on 01462 489000. You can fax through a copy of your printed proof of OU study to 01462 480213 or scan it and then e-mail it to [education@adeptscience.co.uk](mailto:education@adeptscience.co.uk). The total price for the student edition is £88.13 including delivery and VAT.

*If you have any queries please call Adept Scientific on 01462 480055.*

#### **(v) Specimen examination paper (SEP) and Solutions**

In this mailing you will find a SEP for MS221. We suggest that you put the specimen paper on one side until you have finished working through the course materials and completed all the assignments.

It is recommended that the SEP is used as a 'mock' paper towards the end of your revision of the course, especially if you haven't taken an examination in recent years. You are therefore advised to do the paper under as near to examination conditions as possible. That means tackling it when you have a good stretch of time when you are unlikely to be disturbed. As far as possible you should attempt the questions without reference to the course materials or your notes – you can always check against these later. Remember, however, that you are allowed to use your (annotated) handbooks and a calculator in the examination. In fact working through the SEP might identify some extra annotations that you would like to put into your handbook. Try not to look at the solutions until you have tackled as many of the questions as possible. As you look at the solutions, notice in particular how much (or how little) has been written in order to gain each mark.

The SEP should *not* be taken as a blueprint for the actual examination; for example, just because a particular topic is not included in the SEP this doesn't mean that it won't appear in the actual examination paper. The SEP will give you an indication of the structure and the content of your exam, but the way your exam paper looks on the page (font, font size and pagination) may not be identical to the SEP.

If you cannot arrive at an answer given in the solutions for the SEP, it is hoped that you will find the notes at the end of each solution helpful. In particular, make sure you familiarise yourself with the Handbook by looking up the appropriate references.

If you have told the University that you have additional needs your Region Centre will contact you in May to give you information on how you can request appropriate arrangements for the examination, including alternative examination paper formats. Please note that altering the typography of papers that include large amounts of mathematics can affect their readability,



and so we would appreciate an early response to the request for information so we can consider the best possible way to help you.

**(vi) Past examination papers from OUSA (Services) Ltd**

OUSA (Services) Ltd. offers a comprehensive range of past examination papers for Mathematics and Computing courses. For most courses a set of the previous four years papers are on sale. Please note that as Block A of MS221 was rewritten for 2001, Block B for 2002, Block C for 2003 and Block D for 2004, previous years' questions are not all based on the same material as you are studying. You can order by telephone (0870 013 4334) or online at <http://www.ousa.org.uk/>

**(vii) The October examination**

The MS221 examination will be in the afternoon of Wednesday 18th October.

You are advised to spend up to  $2\frac{1}{4}$  hours on Part I, as you should attempt as many of these questions as possible. You are advised to spend between  $\frac{3}{4}$  and 1 hour on Part II, as credit will be given for answers to no more than two questions in this part.

It is recommended that you should spend as much time as you need on Part I of the examination before turning to Part II. Although all the marks available on the examination do count equally, the way in which you gain your marks may be important if your result is on the pass-fail or the Grade 1 pass borderline. To pass the course, the MS221 examiners would like to see a demonstration of a broad knowledge base such as would be shown by answering 8 or 10 questions from Part I successfully. However, for a distinction, the examiners would like a demonstration of ability to follow through a longer question to the end, as well as a broad knowledge base. At the pass-fail borderline your script will be reviewed more favourably if you have answered questions from all four blocks of the course, particularly on Part I, rather than gaining a large number of marks for a Part II question with little else to demonstrate a breadth of knowledge from the other blocks of the course. At the other end of the scale, your script will be reviewed more favourably for a Grade 1 pass if you have answered at least one Part II question fairly fully.

You are advised to take time to read questions slowly and to digest the given information carefully. It has been known for students to waste their time by finding a value which is already given in a question, or to lose marks by not providing exactly what was asked for.

You are advised not to cross through any work until you have replaced it with another solution to the same question. In Part II of the paper, if you submit attempts to more than two questions, your best two scores will count towards your result.

Please note that, if because of special circumstances you are granted the opportunity to delay taking the MS221 examination, or if you take the October examination and as a result are offered the opportunity to resit the examination, then you will be required to take the examination next April.

As a reminder you can take the following items into the examination:

*Handbook*

Remember that you can make as many annotations to your MS221 Handbook as you like provided that you do not use additional sheets of paper. For example, if you find that you have used a result which is not in the Handbook or which is in too concise a form to make sense to you, then insert that result in an appropriate place.

However, you are advised not to cram your handbooks with so many notes that it becomes difficult to find anything. In particular, it is not a good idea to fill your Handbook with worked examples, as these can become confusing when you are working under examination



conditions. The Handbook you take to the examination must be the one that was sent to you and not, for example, a photocopy.

### *Calculator*

Any model of programmable calculator may be taken into the MS221 examination, but not those with a QWERTY keyboard layout (or equivalent for other languages). Any calculator with alphabetic keys that are not in the QWERTY layout, such as most graphics calculators, is permitted. Your calculator should not have a disk drive, should not need to be plugged into the mains, should not be capable of communicating remotely with other devices and should not emit any noise. You may take spare batteries into the examination, but the calculator instruction manual is not allowed.

### **(viii) Course results and expectations**

All aspects of your assessment for this course will be marked on the University Scale, which is detailed in the University's Assessment Handbook (Section 2.3). It has been our experience in the Faculty of Mathematics and Computing that students usually score better on continuous assessment than in the examination. A major reason for this is that the questions set in assignments on most Mathematics and Computing courses, can often, in principle, be answered 100 per cent correctly using the information in the relevant course units. Of course, students rarely do answer all questions in an assignment correctly; but it is only to be expected that high scores will often be obtained and, in particular, higher scores than are usually obtained for courses in other faculties. We try to ensure that examination questions are not harder than continuous assessment questions, but, even so, it is quite a different matter to tackle similar questions under examination conditions. You should bear this in mind when trying to predict your final grade on the basis of your continuous assessment score. We should like to emphasise that there is no reason to be concerned about this difference, which is anticipated by the Examination and Assessment Board for your course and taken into account in deciding your result status, as described in the Assessment Handbook.

### **(ix) M500 Society Study / Revision weekend**

The M500 Society is a mathematical society for OU students. It holds an annual Revision Weekend which this year runs from Friday evening to Sunday afternoon, 8 -10 September 2006, at Aston University, Birmingham. Most maths-related courses are covered, and tuition is given by OU staff. Classes for each course run throughout the weekend, covering the topics you need for the final assignments. It's a splendid opportunity to consolidate your coursework, to get started on your revision, and to meet other students. Bookings open at the end of March, and close on Monday 14 August. Some courses may be oversubscribed, so please book early to avoid disappointment.

|                                                                                                                      |                 |                    |                                                                                           |
|----------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|-------------------------------------------------------------------------------------------|
| For full details and a booking form, send a stamped, addressed envelope to:                                          |                 |                    |                                                                                           |
| Jeremy Humphries<br>M500 Weekend 2006<br>36 Penmanor<br>Finstall<br>Bromsgrove B60 3BZ                               | 01527<br>836571 | jeremy@m500.org.uk | <a href="http://www.m500.org.uk/sept.htm">http://www.m500.org.uk/sept.htm</a>             |
| Annual membership of the M500 Society is approx £12.<br>For details and an application form to join, send an SAE to: |                 |                    |                                                                                           |
| Glenda Franklin, M500<br>16 Warbank Close<br>Alvechurch<br>Birmingham B48 7PA                                        |                 | glenda@m500.org.uk | <a href="http://www.m500.org.uk/membership.htm">http://www.m500.org.uk/membership.htm</a> |



## (x) Course choice

Over the coming months you will be asked to make some decisions about which course(s) you wish to take next, so here is a brief summary of the courses available to you which follow-on from MS221. Much more information is provided in the Course Choice publication and there is also advice and information available via the Open University's website.

*Courses and Qualifications:* <http://www3.open.ac.uk/courses/>

*Credit transfer:* <http://www3.open.ac.uk/credit-transfer>

*Planning studies:* <http://www.open.ac.uk/learning/planning-studies/index.cfm>

If you are planning to study further courses in mathematics we also recommend that you have a look at the following site <http://maths-study-skills.open.ac.uk/>

### **Mathematics**

If you wish to continue your study of mathematics, then there are two 60-point courses at Level 2 which you should consider taking:

|        |                                        |
|--------|----------------------------------------|
| M208   | <i>Pure mathematics</i>                |
| MST209 | <i>Mathematical methods and models</i> |

As you are studying MS221 you are already studying at Level 2, the level of these courses. It is not imperative that you understand every topic in MS221 before moving onto M208 or MST209, but if you are obtaining comfortable passes on your MS221 TMAs, and you intend to complete the course, then you will probably cope with these courses. Calculus is a topic that is central to many mathematics courses, and in particular to MST209. The important topics in MS221 for study of M208 or MST209 are: functions, calculus, differential equations (from MST121), transformations, matrices, eigenvalues, Taylor polynomials and complex numbers. In addition, for M208, it is helpful if you have some familiarity with groups, conic sections and proofs: and for MST209, familiarity with vectors and forces from MST121. These topics will be covered again in M208 and MST209 as appropriate, but more briefly than in MST121/MS221, on the assumption that you have met the ideas before.

M208 and MST209 provide an introduction to the broad areas known as pure mathematics and applied mathematics, respectively, and should both be taken fairly soon after MS221 if you intend to take a number of Level 3 courses in mathematics. If you intend taking both courses, then probably you will find it better to study M208 before MST209. These two courses are an essential part of any degree predominantly in mathematics, and MST209 is also important for studies in physics or engineering. MST209 uses the same version of Mathcad as MST121 and MS221 do, while M208 does not use any specific mathematical software.

If intending to register for MST209, you may wish to consider also taking the 10-point residential-school-based course *Mathematical modelling*, MSXR209, since this is complementary to MST209. It should be studied either whilst you are studying MST209 or after completion of MST209.

Upon successful completion of both M208 and MST209 you will be eligible for the Diploma in Mathematics. This undergraduate-level qualification is a stepping stone on the way to a BA or BSc, including the Honours Degree in Mathematics. (all of MST121, MS221, M208, MST209 and MSXR209 are compulsory courses within the Honours Degree in Mathematics.)

### **Statistics**

|         |                                         |
|---------|-----------------------------------------|
| MDST242 | <i>Statistics in society</i>            |
| M248    | <i>Analysing data</i>                   |
| BM240   | <i>Quantitative methods in business</i> |

All of these follow on from Block D of MST121, though M248 is more mathematical than MDST242 and BM240. M248 and BM240 use a computer, whereas MDST242 does not.



### ***History of mathematics***

MA290      *History of mathematics*

This 30-point course develops some of the historical aspects mentioned in MS221 plus others.

### ***Teaching***

The following courses are available.

| Course  | Title                                                                                                      | Points | Presentation |
|---------|------------------------------------------------------------------------------------------------------------|--------|--------------|
| MEXR624 | <i>Developing mathematical thinking at KS3</i><br>(one week residential school course takes place in July) | 10     | June         |
| ME624   | <i>Teaching mathematical thinking at KS3</i>                                                               | 20     | October      |
| ME625   | <i>Developing algebraic thinking</i>                                                                       | 30     | April        |
| ME626   | <i>Developing statistical thinking</i>                                                                     | 30     | April        |
| ME627   | <i>Developing geometric thinking</i>                                                                       | 30     | October      |
| ME825   | <i>Researching mathematics learning</i> (Postgraduate)                                                     | 60     | February     |

### ***Other***

There are many courses in Information Technology and Computing, Technology and Science, some of which lead on from MS221. Please consult the Course Choice publication for details.

If you would like any assistance in choosing your next course or in planning your degree then please ask your Regional Centre.

### **(xi) Qualifications**

For further information about particular qualifications, please contact the Awards and Ceremonies Centre, PO Box 123, The Open University, Milton Keynes MK7 6DQ, telephone 01908 653003, or go to <http://www3.open.ac.uk/qualifications/>.

### ***Certificates***

The *Certificate in Mathematics* is awarded upon successful completion of any two of MU120, MST121 and MS221.

If you want the credit from MS221 to be counted towards the above Certificate, you must ensure the course is linked to it. You might have already done this as part of the course reservation or registration processes. If you did not do it then, you can do so now by using a transaction that you will find located in the Student Home website at [www.open.ac.uk/students](http://www.open.ac.uk/students). Or you can:

- contact the Awards and Ceremonies Centre on 01908 653003 and ask one of our Advisers to do it for you;
- contact your Regional Centre and ask an Adviser to do it for you;
- send your request in writing to the Awards and Ceremonies Centre at The Open University, Walton Hall, PO Box 123, Milton Keynes, MK7 6DQ.

### ***Degrees***

MS221 is either compulsory or highly desirable for any named degree with 'mathematics' in its title. In particular, MS221 is compulsory in the following degrees:

|                                   |                                     |
|-----------------------------------|-------------------------------------|
| BA / BSc Mathematics              | BA / BSc Mathematics and Statistics |
| BA / BSc Computing and Statistics |                                     |

MS221 may specifically be counted towards the following degrees:

|                                                     |                                              |
|-----------------------------------------------------|----------------------------------------------|
| BA / BSc Computing and Mathematical Sciences Degree | BA / BSc Economics and Mathematical Sciences |
| BSc Physical Science                                |                                              |

It may also be counted towards the 'free choice' element of many other qualifications.



## (xii) Stanley Collings Memorial Prize 2006

Stanley Collings was a member of the Mathematics Faculty (as then was) from 1969 until 1981, as a statistician and geometer. He took great delight in problems with a novel twist to them. Never mundane, those he composed were always intriguing and – above all – fun to solve. In his honour, we now invite you to submit a problem (or a suite of related problems) of your own which, whilst not necessarily wholly original in content, should be presented in an interesting setting. The problems will be judged according to all of the following criteria:

- attractiveness and interest in the way in which the problem is posed; the judges particularly stress the need for the problem to be presented in a pleasing manner;
- suitability of the problem for its potential solvers;
- clear explanation of mathematical concepts inherent in the problem and of the thinking processes involved in its solutions;
- development of the idea behind the problem and some suggestion as to how it might be generalised.

The winning entry will be awarded a prize of £100 and its composer will be notified early in 2007.

Participants should note the following regulations.

- Entry is restricted to those studying an Open University mathematics course (i.e. a course with an M in its code) in 2006.
- All entries should be accompanied by an Entry Form (see below).
- Entries should indicate who the problem is intended for (e.g. school children year 7-8, MST121 students, etc).
- Participants should provide a solution or an indication of a method of solution, where appropriate.
- Entries are expected to be no more than about four sides of A4 in length, and should be legible.
- Entries will become property of the Open University and may be posted on the Web.
- The judges' decision will be final.

Please send your problem, together with the Entry Form below, by 31 December 2006, to *Stanley Collings Memorial Prize, Courses Office, Faculty of Mathematics and Computing, The Open University, Walton Hall, Milton Keynes MK7 6AA.*

### STANLEY COLLINGS MEMORIAL PRIZE 2006 – ENTRY FORM

Please write in capitals

Full name \_\_\_\_\_

Student number \_\_\_\_\_ Current course(s) \_\_\_\_\_

Address \_\_\_\_\_

\_\_\_\_\_ Daytime telephone number \_\_\_\_\_

Title of problem \_\_\_\_\_

Age and experience of intended solvers \_\_\_\_\_

I wish/do not wish\* my e-mail address to accompany my entry if it is posted on the Web.

\* *please delete as necessary* e-mail address \_\_\_\_\_



